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Network Position and Cognition

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INTRODUCTION

A central issue in administrative theory is the relationship between organization and individual cognition (Simon, 1976, p. 241). Cognitive processes shape decisions (Newell and Simon, 1972; Neisser, 1976). Decision situations vary, however, in their degree of structure; and ill-structured problems evoke cognitive processes that are different from problems that are well-structured (Ungson, Braunstein and Hall, 1981). The present study focuses on the organizational determinants of cognition in an ill-unstructured decision situation, that of judging how product goals are accomplished in a computer software firm.

Accomplishing software product goals is not a well-known process both because software is a complex product in its design and interface with users and because software firms face substantial uncertainty with regard to product success. The market for software products is both highly segmented and growing rapidly (Goetz, 1978), and the state of the art in software development is changing as new attempts are made to increase both its flexibility and efficiency (Van Tassel, 1978; Spier, 1975; Lecht, 1977). As problems common to an industry become more ill-structured, not only should different judgments about their solution appear across firms but within firms member judgments may vary substantially.

Explaining why organizational members vary in the way they perceive how software product goals are achieved is the focus of this research. This type of cognition is studied as a causal inference model (Ungson et al, 1981; Azjen, 1977; Tversky and Kahnemann, 1980). Taking a relatively narrow and

specific focus, I represent an inference model as a two-tier system of means and ends where the ends are software product goals. This approach to means-ends relationships can be thought of as an individual differences version of Tversky and Kahnemann's (1980) model of causal schemata which is related to cognition as an event categorization process (Rosch and Lloyd, 1978; Mervis and Rosch, 1981). An event categorization model of causal inference does not rely on probability estimates of means-ends linkages, and is therefore appropriate for investigating judgment tasks under uncertainty.

Individual differences in the perception of means-ends associations are predicted here by characteristics of work experience. The first of these is the position a firm member occupies in the intra-organizational network of task-oriented relationships. This general proposition is consistent with the view that problem-solving under uncertainty in organizations is frequently a multiperson phenomenon (Ungson et al, 1981; Connolly, 1976; Van de Ven, Delbecq and Koenig, 1976). In contrast to the tradition in which multi-person decision-making is limited to small groups (Bavelas, 1950; Shaw, 1954) the present approach to the network is organization-wide in scope and analytically unconstrained by local group boundaries. Furthermore, positions are defined empirically, and one or more firm members may occupy a position in the network. The rationale for taking this approach to explaining differences in causal inference models using network phenomena will be presented below.[1]

The other determinants of differences in causal inference are the type of work performed on a product and for product users; variation in experience

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[1]Software firms provide good opportunities for studying the network extending throughout an organization for two reasons. First, the process technology of software organizations is labor intensive and requires specialized skills which are frequently spread across task groups; second, firm members often work collaboratively on more than one project at a time. The level of product-related interpersonal interaction should therefore be relatively high.

with different kinds of product in the organization and with the industry in general; and differences in exposure to the pressures of socialization in the job and the firm. These aspects of work experience may be related theoretically to network position; and in fact empirical relationships exist, as will be shown. However, in the present study, these relationships are controlled for in tests of the hypotheses rather than explained through a more elaborate theory.

THEORY

Dimensions of Causal Inference Models. For firms facing a market growing as fast as that for software products, member judgments of differences between the ways short and long term outcomes are achieved should be an important asset. Likewise, with technically sophisticated products and generally unsophisticated users, software firms should benefit from having members who can contrast accomplishing success in the eyes of users with achieving the technical goals of product developers. These practical considerations indicate two dimensions along which product goals can be arrayed in software firms. First, the "term" dimension defines whether product success occurs in the short or long term; the second dimension, labelled "boundary", pertains to whether product goals are met in the eyes of product developers (here, members of a software firm) or the eyes of product users outside the firm.

Firm members have a practical interest in the term and boundary aspects of product goals but may perceive these dimensions more or less strongly. For example, some firm members may perceive that short and long term goals are achieved in different ways. Other members, however, may not make such a distinction. Thus, a dimension is salient when its states are highly differentiated in the judgment of means-ends relationships.

These potential dissimilarities in the way members view the accomplishment of product goals are important because they may entail different allocations of time or resources to the various means through which the goals are achieved. If a member sees all product-related activities leading to short and long term goals in equal degrees, then removing resources from any activity in favor of another will not imply a trade-off between the goals. On the other hand, if a member judges that the activities contribute to the goals in different degrees, resource redistribution might indicate substantial tradeoffs. Individual variation in the salience of the term and boundary dimensions is thus an important input to product-related problem solving in software firms and is what this study attempts to explain.

<u>Networks</u>. A major assumption of the present research is that the types of relationships members have with each other characterize inputs to causal inferences (Simon, 1975). To discern the effect of a network of relationships on cognition, therefore, the relationships composing the network must be matched to the content of the judgment task in a critical way. In the present case inferences about the achievement of product goals are assumed to be dependent on input from interactions whose content is task-oriented.[2]

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[2]Task-oriented relationships may involve product or process issues. The focus here on product as opposed to process goals is compatible for a number of reasons with the interests of computer software firms. First, the market for software products is emerging (Porter, 1980) and characterized by high technological and market uncertainty. Firms in such industries emphasize product over process decisions since the implications of product decisions are easier to identify (Hofer and Schendel, 1977, p. 108). Second, the concern with product over process in software firms is reinforced by the technology of software production. Once a program has been written and made into a commercial product, the cost of manufacturing copies is minimal; production (as opposed to development) costs are estimated at .1 to 5% of total cost (Goetz , 1978). Therefore there is little incentive therefore to reduce the variable cost portion of total cost through process innovation. Third, the major part of total software cost is labor, and the labor intensity of software production further reinforces product over process concerns for two reasons: 1) software firms experience decreasing returns to scale for labor input (Brooks, 1975); and 2) programming efficiency may ultimately depend on the quality of the software used as programming tools (Lecht, 1977).

Through their task-oriented interpersonal ties firm members give and receive both direction and information for the accomplishment of product goals, and member inferences about product outcomes should reflect this behavior. Five types of functional relation compose the network studied in the present research: reporting, dependence for information, feedback on performance, problem referral and dependence for extra resources.

Of the five types of relation, reporting alone reflects only the formal authority system. The transmission of product-related subgoals is a central purpose of reporting relationships, and subgoals are usually seen as imposed by superiors on subordinates (Ouchi, 1978). However, the transmission of product-related information may be bilateral (Evans, 1975).

The other types of tie may coincide with the formal system or breach it. For example, referral of product problems between firm members is akin to adjacency in the workflow (Chapple and Sayles, 1961; Comstock and Scott, 1977); but unlike workflow ties problem referral may be nonroutine and, in the present research, is a relationship between individuals rather than activities. The problems individuals come in contact with should provide them with information about the product and also direct their attention to deficiences in the process of goal achievement.

The network of information dependence by definition maps the flow of information in a firm. In addition to technical information flows (Tushman and Scanlan, 1981; O'Reilly and Roberts, 1977; Fombrun, 1980) the present study is concerned with dependence for marketing and administrative information, which involve product-related issues. The distribution of information in an organization may have a directive influence on inferences of how product goals are reached (March and Simon 1958, Chapter 6).

Feedback on work performance enhances the flow of the different kinds of information, since an important effect of task-related feedback is information

sharing with respect to a particular activity (Kim and Hamner, 1976). Individuals who share the same respondents in feedback relationships are thus exposed to the same task information inventories and may be directed towards similar goals.

Finally, dependence on others for extra resources entails the transmission of product-related goals and information. Relationships based on discretionary resources may involve justifications for requesting resources or advice on resource use. Furthermore, discretionary resource transactions should occur more frequently between individuals whose product-relevant goals are not in conflict than between those whose goals differ.

Given a set of relations whose content affects causal inferences about product goals, how is the organization-wide network defined by these relations associated with variation in causal inferences among firm members? The answer depends on how the network is characterized.

Studies of interpersonal networks in organizations have a long history (see Tichy, Tushman and Fombrun, 1980 for a review), a significant aspect of which is the large number of ways networks have been defined. Burt (1980) classifies network research according to both level of analysis and type of analytical approach. Three levels of analysis -individual, subgroup, and system- are specified; and network models are broken into two types of analysis, the relational and positional approaches. The typology is useful because it provides a way of understanding how different characterizations of the network might affect individual causal inferences.

Studies based on the relational perspective approach network phenomena from the frame of reference of the actor or of a pair of actors. Relational analysis at the individual level involves assessing the multiplexity or extent of an actor's personal network (see Schwartz and Jacobsen, 1977); at the subgroup level, cliques of actors are identified (Tichy, 1972; Lincoln and

Miller, 1979); and at the system level, the relational viewpoint concerns either the pattern of transitive relations in triads of actors (Holland and Leinhardt, 1978) or the overall density of ties in the total population. At the individual and subgroup levels, network analysis according to the relational viewpoint fails to capture how task-oriented linkages throughout a firm might influence individual cognitive processes and therefore is inappropriate for the present research which is concerned with the network organization-wide. At the system level, however, network density may be associated with the homogeneity of causal inferences in a population of actors (Canetti, 1962, pp. 29-30). Likewise, high transitivity implies stable relationships over time. Thus, inference processes in an organization whose network is dense and whose pattern of local transitivity is high should be more similar across individuals and more stable than those in a firm with sparser ties and greater relational intransitivity. Density and transitivity characteristics do not indicate, however, how differences in causal inference are systematically distributed within an organization. The relational approach, therefore, is not adequate for conceptualizing network phenomena in the present study.

The positional approach, on the other hand, examines the network from the population frame of reference. Because the positional approach includes the ties among all firm members, characteristics of the network at the individual, subgroup and system levels of analysis may indicate how organization is associated with cognition. At the individual level, a positional analysis might examine the implications of actor centrality in a organization (Evans, 1975); at the subgroup level, actors might be categorized according to the structural equivalence of their relationships with others (Lorrain and White, 1971; Burt, 1978); and at the system level, the structure of relationships among sets of structurally equivalent actors (Boorman and

White, 1976; Breiger and Ennis, 1979) might be derived and interpreted. The implications of organization-wide network effects on cognition vary across the three levels, however.

At the individual level, greater centrality may indicate both extensive access to product-related direction and information and, at the same time, information overload, restricting the span of attention (Evans, 1975). Highly central individuals thus have more input for making inferences about achieving product goals but have less time to spend on each input source. But members with similar quantities of input need not be exposed to similar directional and informational content, since their links to the rest of the organization may not patterned in the same way. The distribution of relational content is important because the pattern of task-oriented subgoals and information is typically highly differentiated in an organization (March and Simon, 1958, Chapter 6). This differentiation should be reflected in the content of task-relations and subsequently in causal inferences concerning product success (compare the argument linking organization design and cognition in Ungson et al, 1981, p. 130).

The problem of the number as opposed to the content of task-oriented relations is overcome at the subgroup level. In subgroups created on the principle of structural equivalence, individuals are combined whose ties to the rest of the organization are the same or similar. Individuals who are structurally equivalent thus convey and receive product-related goals and information to and from the same set of organizational members and, by virtue of their common exposure to the organization, may share the same array of input to making causal inferences about product goals. Because subgroups of structurally equivalent actors, commonly called positions (White, Boorman and Breiger, 1976; Burt, 1976), are defined from the organizational frame of reference and at the same time indicate how members are exposed to specific

product related goals and information, they are an attractive way to conceive the effect of the organizational network on cognition. This approach therefore, is used in the present research.

A number of studies have shown a correspondence between structural equivalence in a network and psychological attributes (Breiger and Ennis, 1979; White, Boorman and Breiger, 1976). Interpreting these results typically involved viewing the network from the positional perspective at the systems level. Thus psychological variation in the firm was related to the pattern of inter-positional relations. Although this approach has exciting possibilities, applying it becomes very difficult in all but the smallest organizations, since the number of interconnections among subgroups increases exponentially with the size of the network, assuming that the subgroups themselves remain roughly the same size. Due to the size of the firm studied, this difficulty was encountered in the present research. Consequently, the network is characterized here only in terms of structurally equivalent actors at the subgroup level.

Membership in the firm bounds the population of actors studied here. The organization is a convenient but meaningful network boundary since for most members the firm is the major source of product-related goals and information. The present research does not consider therefore the relationships of firm members with other members of the software industry. In contrast to interaction with product users, which has direct implications for the way in which firm members perceive the boundary dimension, interaction with members of the industry implies information transmission of a kind similar to that found inside the organization. Deriving structurally equivalent groups for the industry network in which the firm studied here is embedded was beyond the scope of the study.

Hierarchical level and function (e.g., marketing, product development) are assumed to have have effects on cognition separate from that of network position. The firm-wide network thus transcends groupings of individuals based on functional or hierarchical attributes. It overlaps groupings based on ascribed power as well. The present research, therefore, does not assume that a dominant group of decision-makers (Cyert and March, 1963; Thompson, 1967) is isolated either relationally or, by hypothesis, cognitively from the rest of the organization (contrast also Parsons, 1960).

None of the types of task-oriented relation alone is proposed as sufficient to map the transmission of product-related input between firm members. However, in combination the relations may define such a pattern. Consequently,

1. Organizational members who are structurally equivalent in the network defined by the five functional relations will be more similar in their perceptions of term and boundary, as dimensions of causal inference models concerning product goals, than members who are not structurally equivalent.

Nominal Role.[3] In addition to position in a network of task-oriented relations, firm members may be influenced in their perceptions of product goals by functional and hierarchical role. Organization structure defined in functional and hierarchical terms has been found to predict individual differences on a number of psychological attributes (Herman, Dunham and Hulin, 1975; Berger and Cummings, 1979). Dearborn and Simon (1958) found that businessmen tended to interpret problems in terms of the function (sales, production) they performed. Sonnenfeld (1981) expanded this research by examining how differences in hierarchical level affected the way individuals perceived the causes of price-fixing behavior.

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[3]The term "role" is used here as a nominal attribute and is not meant to be confused with its definition in the blockmodelling literature (see White, Boorman and Breiger, 1976, p. 770; Boorman and White, 1976, pp. 1388ff).

In the present study I investigate two types of functional role -technical and marketing- and two levels of hierarchy -management or non-management- and view their relationship to causal inference models from two perspectives. These nominal roles are viewed first in the way they add value to product and second as indicators of the content of communication with users. Technical and management roles may affect perception in both ways; but because the marketing role inherently involves contact with users, I investigate its effect only as a type of communication content.

The contribution a role makes to product goal achievement should lead to a particular way of perceiving how goals are achieved (Simon, 1964). As members of the firm look out into the market, some perceive that user-defined types of goal are accomplished differently from developer goals. These perceptions are motivated by a concern with satisfying users. Thus if users are important to a member's role, as they might be, for example, to product management, that member should differentiate between the ways user and developer-based types of success are accomplished. Furthermore, the more firm members whose contribution depends on user judgment are involved with products, the more the differences between user and firm based criteria should be perceived. Technical personnel should not make such a distinction since their contribution does not concern users but involves making the product efficient and functional and perhaps, creating new product versions. Therefore, the hypotheses are:

2. The longer a member has worked on products in a management role, the stronger should s/he perceive the difference between firm and user-related types of product goal.

3. The longer a firm member has worked on products in a technical capacity, the less strongly s/he should perceive the boundary dimension of product goal.

Because software firms have an intensive technology (Thompson, 1967, Chapter 2), no single role dominates the boundary spanning relationships between users and the organization, as marketing might in firms with long-linked technologies. Thus, in contrast to many previous studies of boundary spanning behavior (Miles, 1977; Tushman and Scanlan, 1981), the present study examines a <u>variety</u> of roles relating the external market and the organization.

Boundary-spanning managers and, in addition, marketers, should recognize that user defined product goals may be accomplished in a different way from developer defined goals. Technicians, however, are focused on development and maintenance problems and do not distinguish between the ways user and developer-based product goals are reached. Furthermore, the effect of all roles on the perception of product goal achievement should be stronger the more strongly they are exercised. Just as the role a firm member performs with product is weighted by the extent of involvement with products, role with users is weighted by frequency of user-related communication. The hypotheses follow:

6. The greater the frequency of communication a firm member has with users in a technical capacity, the less salient should be the boundary dimension of product goal.

7. The more frequently an individual communicates in a marketing role with users, the stronger should his or her perceptions be of the difference between user and firm-related types of product goal.

8. The more frequent a firm member's communication with users as a manager, the more strongly should s/he perceive the boundary dimension of product goal.

<u>Product Type</u>. Types of software product may differ in the length of their life cycles, shorter cycles leading to the need for extensive product modification (Goetz, 1978). The greater the requirement for modifying a product, the more appreciative a firm member working on that product should be of the differences between short and long term goals. The present research studies three types of software product: systems, applications and

telecommunications. Of these types, applications products should require the most modification because they are susceptible to shifting user needs than are the other product types. All three types are subject, however, to changes in hardware specifications which have become more variegated due to changes in microprocessor technology. Consequently, extensive experience with any of the three types may induce an appreciation of the term dimension. The hypothesis follows:

9. The longer a firm member has worked on a particular type of product, the stronger will his or her perceptions be of differences in the ways short and long term product goals are achieved.

<u>Experience in Industry</u>. Veterans, more so than newcomers to the software industry, will typically have seen a number of products reach their greatest share of the market and either decline or be transformed into more current versions. The more extensive a firm member's exposure to products over time, the more should s/he see how differently short and long term goals are accomplished. Thus,

10. The longer an individual's tenure in the software industry, the more strongly will s/he perceive the term dimension of product goal.

<u>Tenure in the Firm and Job</u>. Tenure in a firm and job should have a different effect on individual causal inference models. According to Schein (1978) organizational members are more open to innovation and change at the midpoint of their passages between the inter-and intra-institutional boundaries they cross to advance their careers. Individuals experience the pressure of anticipatory socialization if movement across the boundary is about to occur and the pressure of new role expectations if they have just crossed a boundary into a new group. Schein's theory is that such pressures reduce the probability of creating new ideas. Thus socialization and innovation alternate in a counter-cyclical pattern.

In the present research innovative ideas are related to perceptions of the term dimension. Thus tenure should have an effect on the perception of differences between short and long term goal. Because the advent of a new job often cannot be predicted, the effect of anticipatory socialization cannot be assessed. The influences of job and firm tenure on perceptions of time are therefore assumed to be linear. The hypotheses are:

11. The greater the tenure an individual has in his or her job, the stronger should be his or her perception of the term dimension.

12. The greater the tenure of an individual in the firm, the more strongly should s/he perceive the term dimension.

RESEARCH DESIGN

Measuring individual causal inference models first involved the construction of a questionnaire which could capture adequately differences among firm members in the way they perceived the achievement of product goals associated with states on the term and boundary dimensions. To simplify the task, it was assumed that two states composed each dimension. Consistent with the theory presented, these states are short and long term for the term dimension,[4] and user and developer perspectives on product success for the boundary dimension. A prototypical product goal was then defined for each combination of states. For convenience, these goals are labelled performance, coherence, generativity and currency (see Figure 1) and are now described.

Performance

Performance is a type of product success which occurs in the short term and is based on criteria establisned by product developers. For software products, performance is indicated by the event which combines efficiency in run time and storage space and the achievement of design goals. The efficiency and effectiveness of a software product have long been important considerations in the evaluation of the product's technical worth; and consequently, many rules and procedures for improving them have been suggested, aimed both at the process of managing projects producing software (Brooks, 1975) and at the structure and content of the code (Van Tassel, 1978). These methods are themselves a matter a debate (Spier, 1977), indicating that fixed standards for achieving a high performing software product are not yet generally accepted. Consequently, the cognitive maps of software specialists may vary in the degree to which certain events are seen to be important for software performance.

Generativity

The development of new products is an important concern of software firms. In addition, in order to respond to frequent changes in user needs, a software product must be reworked into a new version of itself. Products that either have valuable parts which contribute to new product development or can be easily modified into new versions of themselves are defined here as generative. Unlike performance, generativity takes place in the long term; but, like performance, generativity is a criterion of success based in the firm.

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[4]Goetz (1978) shows that the income streams from software products are highly unpredictable; long term goals may therefore be seen as qualitatively different from short term product success. (See also Hayes and Abernathy, 1980.)

FIGURE 1

A.

Boundary		Term: Short term	Term: Long term
	Product Development Perspective	Performance	Generativity
	Product User Perspective	Coherence	Currency

B.

Type of Goal	Description
Performance:	The product meets its design goals and runs efficiently in time and space.
Generativity:	The product can be easily made into new versions of itself and contributes to new product development.
Coherence:	The product is accepted, understood and used effectively by users.
Currency:	The product can meet the new needs of current users and the needs of new users.

Coherence

A software product is most often used by people outside the organization that developed it. These users are generally unfamiliar with the detailed technical properties of the product but can be expected to understand its purpose and use it effectively. A software firm can work on making its products more understandable and acceptable to users; the verdict, however, is in user perceptions, not those of the developer. The coherence of a product is defined as a type of success involving effective use of the product outside the development organization and occurs in the short term.

Currency

Current users of a product will develop new needs which a product must satisfy. Furthermore, new users may have needs for managing information that are different from the needs of old users. The currency of a product refers to its continued viability for old users Like coherence, currency is a function of factors outside the organization. A product's ability to satisfy new requirements, whether or not the product's design has changed, is the key determinant of currency; a product will sometimes do more than it was originally meant to do. Currency, like generativity, implies success in the long term.

In a software products organization,[5] eight nominal groups (Delbeq, Van de Ven and Gustafson, 1975) were run to derive a list of events[6] which were thought by firm members to contribute to overall software product success. The groups produced a list of 352 events which was reduced to 52 through a content analysis. Because these events were elicited by referring to product success in general, some might contribute in the same degree to all four types of product goal and therefore be poor indicators of differences in product goal accomplishment. To identify these events a pilot

[5]The company is publicly owned. Current revenues approximate twelve million dollars. The firm has held contracts with most of the large computer hardware manufacturers and continues to benefit from short term contracts with a variety of firms both within and outside the computer business. The firm did not use its own products.

[6]Event is a generic term and describes product developer and user behavior, product characteristics, characteristics of the organization, and other factors which firm members see as contributors to product success.

TABLE 1

Events Selected as Contributors to Types of Product Success

1. There is close contact with the end user during development.
2. The developer has a precise picture of who will be using the product.
3. The product is portable across machines.
4. Product structure is modularized.
5. The development team has intrinsic ability.
6. An effective user system can be demonstrated.
7. The price of the product.
8. The vendor is committed to the product.
9. The product has good documentation.
10. The developer knows trends that affect the life of the product.
11. The development company has a good reputation.
12. The product developer supports the user.
13. In a phased approach to product development, each phase is completed by knowledgeable individuals.
14. What base software and hardware the product runs on.
15. Product has unique aspects from the users point of view.
16. Product delivery is on schedule.
17. Product solves a timely problem.
18. The development organization supports the product all the way thrugh.
19. The product is easy to use.
20. The product is easy to install.
21. The terms and conditions associated with licensing and purchasing the product.
22. The product is pilot tested.
23. The level of experience required of the user.
24. The users of the product are trained.
25. The product is highly advanced technologically.
26. The product interfaces easily with existing product of the vendor.
27. Using the product is efficient in terms of human resources.
28. The number of bugs encountered when the product is installed.
29. The product is accurately represented by marketing.
30. The product approaches a problem in a way that seems natural to the user.
31. The user has a specific requirement.

test questionnaire was distributed to seven members of the firm, drawn from different functions and hierarchical levels. In the questionnaire respondents were asked to indicate how strongly (on a five point scale) each of the events led to the accomplishment of each of the four product goals, which were presented according to their descriptions in Figure 1B. A two-factor analysis of variance of the pilot test responses showed that thirty-one events discriminated well among the four goals. (Cronbach, Glaser, Nanda and Rajaratnam, 1972) These events (see Table I) were used to construct a second questionnaire with the same format. This questionnaire was sent to 150 members of the organization.

These members were chosen because they were directly involved in either product development, quality assurance or marketing. The participation of these members in the product flow should have provided a basis for answering both causal inference and network questions. Secretaries and administrative personnel returned the causal inference part of the questionnaire unanswered because they felt unable to answer questions about product goals. Ninety-three responses were usable, a rate of 62%. No systematic bias across offices or functions was apparent in the responses.

Matrix centered by subject, responses were input to CANDECOMP (Carroll and Chang, 1970) an n-mode, n-way individual differences scaling program (see Carroll and Arabie, 1980). The results of the CANDECOMP procedure showed how the goals, events and individuals were related to the same set of dimensions. It was hoped that these dimensions could be interpreted as "term" and "boundary" and therefore that the respondent weights on the dimensions indicated the strength with which the term and boundary components of product goals were perceived.

Task oriented relations in the firm were measured using questions in which respondents made choices from the list of 150 members.[7] A respondent was asked to indicate those to whom s/he "sent" a relationship (e.g., referred

problems) and those from whom s/he "received" a tie (e.g., received problems referrals) for all relationships except reporting, which was measured from the subordinate's point of view. Five point frequency scales were used to assess the strength of problem referral and feedback ties. Also, respondents were asked to specify which other firm members they had depended on in the previous six months for three types of information -technical, marketing or administrative- and an additional category -more than one information type. Finally, four types of discretionary resource transactions -money, time, equipment, and people- and a fifth category -more than one type of resource- were measured in the same way as information. Again, ninety-three respondents produced usable questionnaires.[8]

The method used to analyse the raw network data is called blockmodelling (Arabie, Boorman and Levitt, 1979; White, Breiger and Boorman, 1976; Boorman and White, 1976) and involves the use of two algorithms in the present case - CONCOR (Breiger, Boorman and Arabie, 1975) and CALCOPT (Boorman, 1981). CONCOR is a clustering algorithm that splits the membership of the organization into two groups and hierarchically and successively into further groups until 1) a desired number of subgroups is obtained, or 2) the subgroups have roughly a certain number of members. The members of each subgroup are defined as structurally equivalent to each other. The partition produced by CONCOR was used as a rational initial configuration for CALCOPT. CALCOPT

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[7] Holland and Leinhardt (1973) recommend the listing of all firm members as the technique with least inherent measurement error.

[8] Although the problem of network sampling in studies of structural equivalence is not yet well understood, Brieger (1976) has shown empirically that the distribution of individual characteristics across subgroups in a sample is quite similar to the distribution in the population from which the sample was drawn.

alters the membership of the subgroups, iteratively, until no reassignment produces a better value of a target function.[9]

The type of product worked on was scaled by longevity and frequency of involvement with the product. A respondent's score for a particular product was computed by multiplying the length of time and the frequency of work on the product. The scores for products of the same type were added to formulate the respondent's score for that type. Similarly, for each of the two roles with product, subject scores were calculated by multiplying the length of time spent working on product times the frequency of time spent on the product and then summing over all products with which the respondent had a particular type of relationship. In contrast, subject scores for the types of function with users were weighted by the total frequency of communications in three modes --face-to-face, telephone and written-- with users for whom the function was exercised. Finally, tenure in the industry, firm, and job were measured by single questions.

Although the measurement of both cognitive maps for product success and network position were performed on samples of roughly 62%, measurement of the other predictors of cognition (role, tenure, type of product) reduced the number of usable cases from 93 to 55, resulting in an effective response rate of 37 percent. The pattern of missing data had no systematic relationship with either the results of the scaling solution or the work group structure of the firm (see Kim and Curry, 1977). The 55 cases were therefore accepted as representative of the population.

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[9]The target function used in this application was increasing the sum of the squared distances between the intergroup densities and the mean density for all types of relation. The target function of CALCOPT is based on a measure of blockmodel fit developed by Carrington and Heil (1981).

The hypotheses were tested using analysis of covariance where network position constituted the grouping variable and the other independent variables the covariates. The covariance analysis was performed both with and without a stepdown. A comparison of both approaches indicated how strongly the relationship between the network and the other variables affected the stability of the results.

Results

The individual differences scaling of judgments by firm members about product goal achievement showed that the two theoretical dimensions -term and boundary- could be identified empirically (see Appendix A). Schiffman, Reynolds and Young (1981) point out that independence can be attributed to individual differences weights produced in a scaling solution only when the pattern of event weights is stable across judgment situations. As discussed in Appendix A, the empirical dimensions measured here were found to be stable across both time and method.

The measurement of network subgroups is presented in Appendix B. The positions were found to have strong face validity when matched to the geographical office structure of the firm and when interpreted in terms of the pattern of reporting relationships. Also, the relationships composing network were found to be quite stable over time.

It seemed likely that the network position of a firm member was strongly associated with the other independent variables. To investigate this supposition, a multivariate analysis of variance was conducted between network position and the other predictors. Using the maximum root test (Anderson, 1958), network position was found to be significantly ($p < .01$) related to the other predictors of both the term and boundary dimensions, implying that the estimated effects on cognition may be unstable due to multicollinearity.[10] To assess the extent of the problem, the hypotheses were tested in a stepdown analysis of covariance, once with network position entered first, and then with the other predictors first.

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[10]The multicollinearity within each set of predictors was found to be insubstantial, using Bartlett's (1950) test for the orthogonality of the determinant of a sample zero-order correlation matrix (see Farrar and Glauber, 1967).

The results for the boundary dimension are shown in Table 2. The null hypothesis that no variables have an effect on perception is rejected ($p < .1$). When the effect of the network is controlled for, two roles, technical with product and management with users, have significant coefficients. The direction of these effects are as predicted: greater time spent in a technical role tends to decrease the salience of the boundary dimension, whereas more frequent communication with users in a management role increases the salience. Network position also significantly influences perception.

The effects of the role variables change when the network is not controlled for. Neither the technical approach to product nor user management remain significant predictors and are replaced by technical role with users, which reduces the salience of the boundary dimension, as hypothesized.

Thus, the role variables, due to their association with network position, show considerable instability in their effects on perception. The network effect, however, is stable. Moreover, adjusted for degrees of freedom the variance explained by network position ($R^2 = .1$) is roughly three times that explained by all the role variables combined ($R^2 = .03$).

The results for hypotheses predicting individual differences on the term dimension are more stable. Table 3 presents the findings for the tenure, type of product and network effects. The hypothesis that no coefficients are different from zero is rejected ($p < .05$). Firm members with long industry and job tenure perceive the term dimension strongly, as predicted; but contrary to prediction, the longer the tenure in the firm, the less salient are differences between short and long term success. In addition, systems and telecommunications products are unrelated to perception of the term dimension; but firm members who are more extensively involved with applications products make weaker distinctions between the short and long term, an effect opposite to that hypothesized. The effects of type of product on the salience of the

TABLE 2

Results for Predicting Perception of the Boundary Dimension

Covariates	Unstandardized Regression Coefficient: Controlling for Network Position and Other Covariates	Unstandardized Regression Coefficient: Controlling Only for Other Covariates
Technical role with product	-.012**	-.005
Management role with product	-.012	.000
Technical role with users	-.077	-.092*
Marketing role with users	-.035	-.043
Management role with users	.361**	.188
		$R^2 = .13$
		adjusted $R^2 = .03$

Grouping Variable	Controlling for Covariates	Not Controlling for Covariates
Network Position	.52*	.58*
		$R^2 = .27$
		adjusted $R^2 = .1$

$F_{15, 39}$ 1.78*

$R^2 = .41$ for all variables

adjusted $R^2 = .16$

**p < .05

*p < .1

TABLE 3

Results for Predicting Perception of the Term Dimension

Covariates	Controlling for Network Position and Other Covariates	Controlling Only for Other Covariates
Work on systems software	-.002	-.002
Work on application software	-.006**	-.004
Work on telecommunications software	..001	.000
Length of industry tenure	.015**	.020**
Length of firm tenure	-.034**	-.023**
Length of job tenure	.023*	.012
		R^2 = .27
		adjusted R^2 = .17

Group Variable	Controlling for Covariates	Not Controlling for Covariates
Network position	.61**	.67**
		R^2 = .37
		adjusted R^2 = ,22

$F_{16,38}$ 3.86**

R^2 = .63 for all variables

adjusted R^2 = .47

**p < .05

*p < .1

term dimension are thus disconfirmed. Finally, network position is strongly related to perception of the term dimension.

Note that the results for both work on applications products and job tenure are sensitive to the inclusion of network position since, without controlling for the network, neither of these variables determines perception significantly. The influence of network position is significant, however, whether the other independent variables are controlled for or not. The variance accounted for by network position (R^2 = .22) is, again, larger than that of the other predictors combined (R^2 = .17).

Thus, although network position is strongly related to both sets of predictors, it strongly influences individual differences in the perception of both dimensions of product goals. However, the effects of the other predictors, except for industry and firm tenure, are sensitive to the association with the network.

Discussion

The measurement of the term and boundary dimensions was found to be stable over time and method, and individual differences in perception were reasonably well predicted. Furthermore, since differences in cognition among firm members were measured with reference to _implicit_ dimensions of relations between events rather than orderings or evaluations of the events on one or more explicit dimensions, response bias should have been minimized. Some confidence can be placed therefore in the theoretical and methodological approach used to assess judgments about product goals.

The results show that with the exception of industry and firm tenure, the predictor variables have unstable effects, due to intercorrelation with position in the network. Network position itself has a strong independent influence on cognition. How generalizable are these results and what are their implications for organizational research?

The generalizability of the research may be limited by characteristics of the organization studied. First, the labor intensity of the firm's technology increased the likelihood that the network would have substantial density. High density of interaction improved the chances that members used similar dimensions to categorize events and that the organization-wide network, viewed from a structural equivalence point of view, influenced cognitive content. Also, the relatively small size of the organization facilitated the measurement of the network. Furthermore, technological change, the market growth rate, and rate of new entry into the industry indicated a high level of product market uncertainty; therefore, product-related problems could be typed as ill-structured. The growth rate and rate of technological change also led to specifying the term dimension as a practical parameter of product goals. The intensive technology of the firm,

made it more likely that members in many nominal roles had some interaction with the firm's customers. Finally, the types of product worked on were specific only to software firms.

The influence of nominal roles on cognition may increase and become less sensitive to the network as 1) the problem-solving situation studied becomes more structured or routine and 2) the labor intensity of the firm's technology decreases. Routine problems may evoke cognitive processes which depend less on input from interpersonal relations and are more strongly associated with task rules (see Van de Ven and Delbecq and Koenig (1976) for a presentation of this phenomenon in task groups). Furthermore, members of organizations with less labor intensity than the software firm studied here may not have sufficient access to others in the firm for the network relationships to overcome the effect of nominal role pressures. Sparse and fragmented organization-wide networks may therefore have no influence on cognition. Task-oriented ties between individuals in local work groups may be influential, however.

The results are those for the influence of firm and industry tenure on the salience of the term dimension are less limited. These effects point to the need for relatively high executive turnover in fast growth industries experiencing technological change. Once within a firm, veterans lose their perspective and fail to distinguish between the different ways of achieving product success in the short and long term.

The effect of firm tenure on causal inference models, which was contrary to that hypothesized, may have been a result of the degree of structure in the judgment situation studed here. Organizational members may learn solutions to well-structured problems early in their tenure and expand on this knowledge in innovative but incremental ways as the influence of socialization diminishes. On the other hand new members may feel forced to structure highly uncertain judgment situations in which older members are willing to see more ambiguity.

Thus the results of the present study regarding socialization in the firm may represent the tendency of older members to appreciate the ill-structured nature of the judgment task. However, because the task was not specific to the firm but applied to the software industry in general, experience in the industry provided information which increased perception of differences between short and long term success. Industry and firm tenure therefore influence judgment for badly structured industry-specific problems in opposite ways.

It is interesting, moveover, that differences in the perception of the term dimension were much better predicted by the network than those of the boundary dimension. This result suggests that individual judgments of time as an implicit parameter of product goals depend more on input from other firm members than judgments concerning differences between user and organizational perspectives on successful product outcomes. Organizing activity in the firm may be related to member perspectives towards present and future goals in a way which is qualitatively different from orientations towards the boundary dimension, and subgroups whose members perceive the term dimension strongly should be located similarly in the structure of the network. This general location should correspond to the upper levels of the management hierarchy, as proposed by Parsons (1960) and Williamson (1981).

To the extent that network position determines causal inferences, it affects the inputs to decision making and therefore to a degree decision outcomes. On the other hand, a member's position in the network itself reflects the global pattern of individual choices about product related issues as represented by the types of task-oriented relations. These choices furthermore are a consequence of previous decisions about the projects the organization would undertake. Organizational members use their contacts to accomplish project aims (Kotter, 1982). The present study shows that this process itself determines individual orientations towards product success and

therefore constrains cognitive input to new decision-making situations. Thus the network transforms the implementation of one set of decisions into the premises by which another set is made.

To what degree can this process be controlled? This question has provoked a number of qualitative models of organizational (as opposed to individual or small group) decision processes. Among these are Gouldner's (1959) distinction between the rational and natural system perspectives (see also Thompson, 1967), Cohen, March and Olsen's (1972) garbage can model and Weick's (1976) model of loosely coupled systems. Both Cohen, March and Olsen's and Weick's models approach the problem of control by specifying where control is absent.

Weick points out that interaction among organizational members and therefore the network of interactions may be a tightly coupled aspect of an organization. The association of means and ends may be either tightly or loosely coupled. Since the results of the present research show that the network is related to the way organizational members perceive the uniqueness of means and ends linkages, tightly and loosely coupled systems may be joined as the content of interpersonal interaction becomes the content of causal inferences. The latter may involve either clear or ambiguous means/ends associations (March, 1977), which in turn should be related to the degree of choice flexibility inherent in the system.

Cohen, March and Olsen's garbage can model specifies four loosely coupled decision situation parameters. These parameters are: choice situations, participants, problems, and solutions. The results of the present study show that the position of participants in an interaction network determines to an extent their orentiation towards problems and solutions proposed in a choice situation. In a sense, the network acts as a selection

and retention mechanism in the evolution of decision-making within the firm. (Notice that problems and solutions with ambiguous means and ends may be selected for.)

The network model in the present study also can be seen as a bridge between Gouldner's rational and natural system models of organization. The link to the natural system follows from the discussion above of how the network relates to the garbage can and loosely coupled systems models of organizational decision making. Furthermore, studies of network structure over time and over populations of actors (Boorman and White, 1976) have shown regularities of development which can not be interpreted as controllable by one or a group of actors.

The network is related to the rational system model through the covariance of the various types of task-oriented tie. Task-oriented relationships can be partially manipulated by those with power to prescribe formal ties between individuals. Informal ties should be correlated with formal relationships, and so the structure of the network is to some extent determined by the powerful group. Assessing the covariance among formal and informal types of tie and the relative contribution of each type to individual differences in cognition are important analytical tasks for evaluating how strongly the network has been rationalized.

Furthermore, task-oriented relationships measured in the present study involved both information and direction relevant to the accomplishment of product goals. The transmission of direction indicates an influence process which some organizational members may manage by maintaining strategically located positions in the network for one or more types of relation (Marsden, 1981). Thus control may be exerted both by specifying formal relationships throughout the firm which affect in various degrees the development of other types of ties and by managing the flow of task-related direction through

structurally determined influence. Further research should show whether these aspects of control over organizational decision-making affect inferences about product goals independently.

Finally, the present study has not examined the ways in which affect might constrain or mediate the relationship between organization and cognition. Both affective input to decision-making and the network of interpersonal relationships based on affect may be empirically separable from the type and determinants of cognition studied in the present research (see, for example, Zajonc, 1981). Separability may not imply independence, however. Further research might identify how inferences and feelings about events are related to position in a network composed of both instrumental and expressive ties. Heise (1979, p. 32-34) suggests, for example, that an individual develops his or her network of interpersonal relationships by selecting others with or through whom affect can be controlled and that cognition is a function of this process. Boorman and White (1976) found in their study of network structures, however, that members of formal organizations tended to suppress negative sentiment in comparison with actors in informal settings. These results suggest that the demands of task accomplishment in formal organizations constrain network development the kind proposed by Heise. Task demands may themselves be a function of affect management strategies, as organizational members establish task-oriented relationships with others who share sufficiently their orientations towards accomplishing product goals. An analysis of the relationships among positions in a task-oriented network should show whether such a correspondence between relational and cognitive continuities exists, and if so, whether the strucutre of positive effect ties can be matched to it.

Conclusion

The present study has developed and tested a theory relating aspects of an individual's work experience to perceptions of how different types of software product goal are achieved. The most important predictor of perceptions was the position, defined in terms of the principle of structural equivalence, an individual occupied in the network of task-oriented relations within the organization. This result indicated that cognition in ill-structured judgment situations is strongly influenced by interpersonal relationships whose content is relevant to the judgment made. The influence of the network superceded the effects of nominal role, job tenure and experience with various types of product but not those of industry and firm tenure. The results may be generalized to organizations with similar labor intensity, market growth rate, and rate of technological change. In addition, the results can be related to other organizational decision-making models. The network can be seen as a link between making and implementing product-related decisions and at the same time as a bridge between the natural and rational systems approaches to organizing activity.

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Appendix A

Measurement of Causal Models

Table A1 presents the results of the two-dimensional CANDECOMP scaling solution [7]. The locations of the events and the types of success are shown together in the two dimensional space. An interesting characteristic of this scaling solution is the high correlation between the dimensions. CANDECOMP does not necessarily produce orthogonal axes, and a commonly cited advantage of the technique is the rotation invariance of the solution (see Carroll and Arabie, 1980, p. 631). It was not possible, therefore, to rotate the axes to increase their interpretability.

The horizontal axis can be labeled the boundary dimension since along it product development types of success are clearly differentiated from the user types. Likewise, the vertical axis can be labeled the term dimension, since the long term types of success lie above the short term types. Note that the development types of success are much closer together on the boundary dimension than the user types, and the user types of success are closer together on the term dimension than the development types.

Although the term dimension is interpretable, the quadrilateral predicted by the product sucess typology is not perfectly produced: currency lies between coherence and performance rather than occupying the fourth corner of what should be a rhombus. The location of currency makes the interpretation of the axes more difficult, especially the interpretation of the term dimension.

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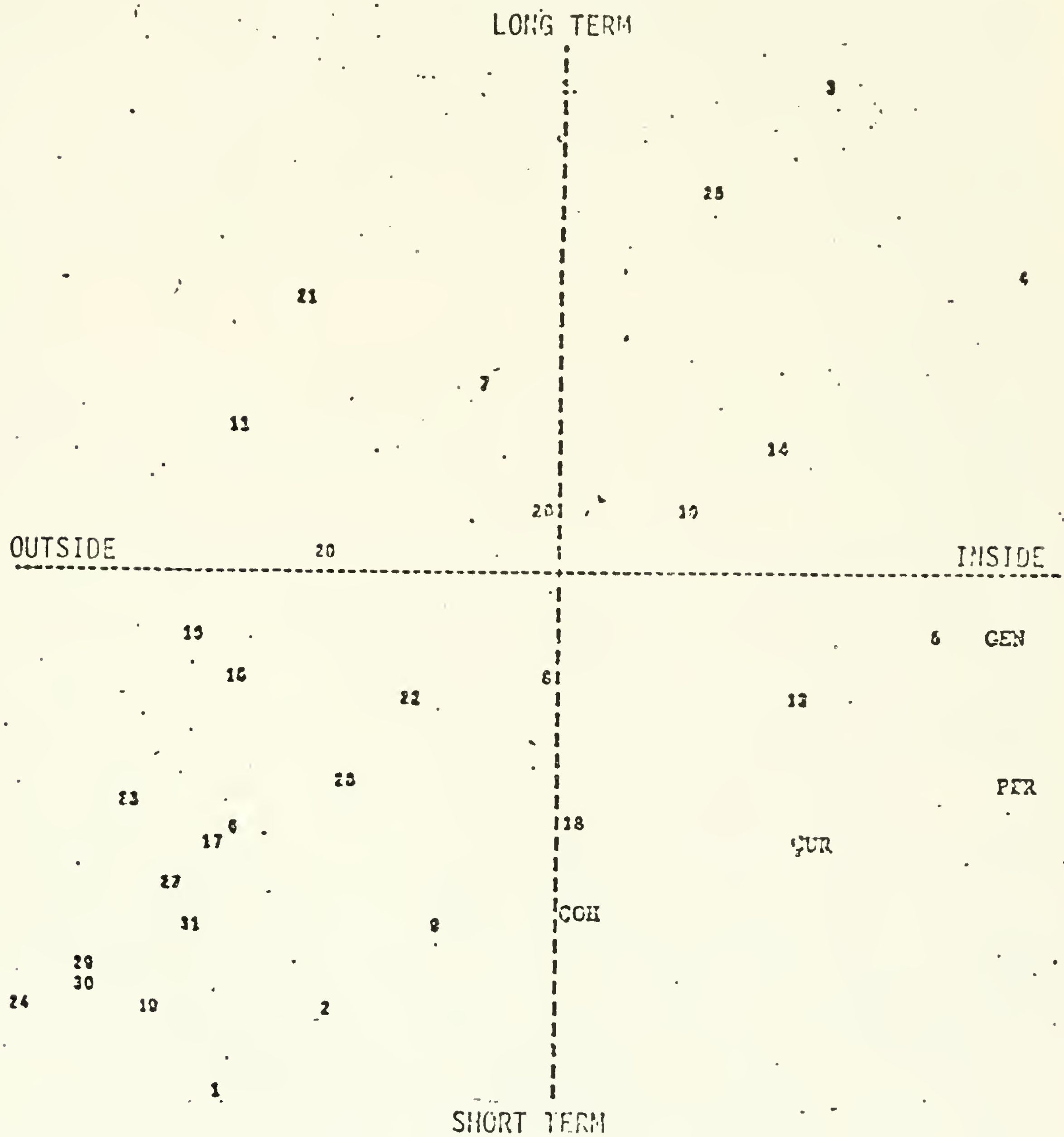
[7] Nine CANDECOMP runs with different randomly chosen initial configuations were made. For all runs, the three dimensional solution explained approximately five percent more of the variance in subject scores than the two dimensional solution. The two dimensional solution was therefore selected for interpretation. The run which offered the best interpretation in terms of the type of success weights was selected to test the hypotheses. The patterns of events and types of success in all solutions were quite similar.

TABLE A1

CANDECOMP Scaling of Thirty-one Events and Four Types of Product

Success - R^2 = .30



Numerals refer to events in Table 1.

The distribution of the events reinforces the interpretation of the dimensions based on the locations of the types of success. Users become more prevalent in events moving from right to left on the horizontal axis, indicating a shift from product success inside to product success outside the organization. Also, at the top of the right side of the space are events which describe characteristics of the product, and at the bottom of the right side are events that describe aspects of the development process, indicating that product characteristics are generally associated with long term success and aspects of development with short term success. However, on the left side of the space, user-product and user-organization relationships are less separable.

The wide vertical spread of events in the right side of the space is consistent with the strong differentation between performance and generativity on the term dimension. The narrow dispersion of the events in the left side reflects the relatively short distance between coherence and currency. This funnelling effect in the distribution of events and types of success is an important result since it demonstrates that subjects have difficulty differentiating between short and long term success when judged by users but no difficulty when success occurs in the eyes of product developers.

To test the stability of this result across time and method four pairs of events were selected from the solution, each pair from a region of the spare that could be associated with a particular type of success. Four months after the first questionnaire was distributed a subset of 65 firm members were asked to compare the eight events, in pairwise fashion, in terms of the similarity of their contribution to product success <u>in general</u> (that is, the types of product success were not mentioned). Responses were input to INDSCAL, a two-mode, three-way individual differences scaling program (Carroll and Chang, 1970; Carroll and Arabie, 1980) with a two dimensional solution

specified. A canonical correlation analysis of the eight event weights on the axes of the CANDECOMP and INDSCAL solutions showed a significant correspondence for both the boundary and term dimensions, $p < .001$ and $p < .1$, respectively.[8]

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[8]The question remained whether the types of success were actually perceived as ends for which the thirty-one events were means. To test this assumption, the eight events taken from the four regions of the CANDECOMP solution were presented with the types of success to the sixty-five firm members in Tversky and Kahnemann's (1980) format designed to identify the existence of causal features. The results showed causality links between the events and all types of success, except currency, which, contrary to expectation, was seen more frequently as causing the events. This outcome helps to explain the distorted position of currency in the scaling results and the funnelling of events on the left side of the CANDECOMP solution.

Appendix B

Measurement of Network Position

In measuring the network, reporting was measured as a binary variable. Responses for feedback and problem referral, which were measured on an ordinal scale, were dichotomized (see Arabie, Boorman and Levitt, 1979, pp. 42-43). The cutoff criterion for each of these relations was median split; that is, relationships which occurred more often than the median frequency were given a value of one and those occuring less frequently were assigned a value of zero. Of the five types of extra resources --time, money, people, equipment and more than one type of resource-- only time and more than one type of resource had a sufficient number of responses to be included in the analysis. Each of the three types of information measured --technical, marketing, and administrative-- had sufficient density to be included in the analysis.[9]

Dependence for information of more than one type was also included. In all, then, seventeen separate relations were used to constitute the network:

1. reporting
2. feedback given
3. feedback received
4. problems given
5. problems received
6. extra time given
7. extra time received
8. more than one kind of resource given
9. more than one kind of resource received
10. technical information given
11. technical information received
12. marketing information given
13. marketing information received
14. administrative information given
15. administrative information received
16. more than one kind of information given
17. more than one kind of information received

---

[9]Low density or sparse relations were eliminated for both substantive and technical reasons. Substantively, relations which were underrepresented in the population had insufficient scope to convey product-related goals and information. Technical difficulties also arose in analysing such relations due to the large number of firm members who did not participate in them.

Frequencies for the categories of each relation are presented in Table B1. Because the analysis was performed on the seventeen types of tie together, organizational members who belonged to the same position were structurally equivalent across all the relations simultaneously. Thus, using a large number of functional ties to define the network increased the robustness of the position memberships produced by the blockmodelling techniques. The significance of measurement error in any one relation for the results was thus substantially reduced.[11]

Binary matrices for each of these relations were stacked (see Arabie, Boorman and Levitt, 1978, pp. 36-37) and submitted to CONCOR. After successive splitting, 14 groups were identified.[11] The splitting sequence is shown in Table B2A. The partition produced by CONCOR was used as an initial configuration for CALCOPT. The initial value of the CALCOPT target function using the CONCOR partition was 215.94, and the terminal value was 452.45, a substantial increase. The number of members in each group after CALCOPT was applied is shown in Table 2B.

The CALCOPT partition, like that of CONCOR, contains 14 groups. A blockmodel was constructed from the density matrices (available from the author) using a zero as the cutoff density to determine zero blocks (Arabie, Boorman and Levitt, 1978, pp. 31-32). In order to portray clearly the pattern of relationships in the blockmodel, the order of the groups was changed. The ad hoc principle of reordering was simply to put groups which contained

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[10]No hard and fast rule exists for the number of groups to be derived. In the present case, groups were split if their size was twelve members or greater, unless, as in one case, the split resulted in separating only one member from the group. Splitting at twelve resulted in groups whose sizes were generally consistent with project teams in the firm.

[11]To test the stability of the responses for each relation, an identical questionnaire was distributed two months later. The correlations of responses across the two questionnaires for the seventeen relations range from .41 (help with extra time received) to .73 (reporting).

TABLE B1

FREQUENCY OF RESPONSE FOR NETWORK RELATIONS

A. Reporting

1. Average number of reporting ties per respondent: 1.13

Total Number of Response Per Category

B. Feedback

	Less than once a month	Roughly every month	Roughly every two weeks	Roughly every week	Roughly every day
1. Feedback received	90	51	41	61	26
2. Feedback sent	96	48	38	94	28

C. Problem Referral

	Less than once a month	Roughly every month	Roughly every two weeks	Roughly every week	Roughly every day
1. Problems received	95	42	28	41	23
2. Problems sent	129	42	38	43	20

D. Help With Extra Resources

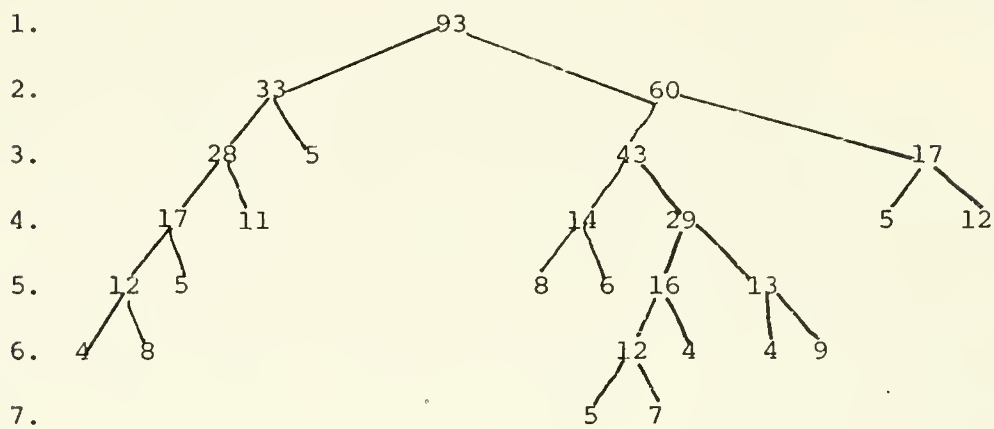
	Time	Money	People	Equipment	More than one kind
1. Help received	26	1	12	5	87
2. Help sent	98	1	8	2	130

E. Dependence for Information

	Technical	Marketing	Administrative	More than one kind
1. Information received	270	73	57	62
2. Information sent	262	79	34	80

TABLE B2
CONCOR SPLITTING SEQUENCE AND CALCOPT PARTITION

A. CONCOR Splitting Sequence



B. CALCOPT Partition

Number of Members in Each Cell of the Partition:

Cells:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
No.:	8	9	4	14	23	5	5	4	5	2	9	1	1	3

Target Function Values:

Initial Partition: 215.94 Final Partition: 452.54

members from the same regional office next to each other. Table B3 presents in nine sets the blockmodel for the seventeen relations. In eight of these sets the blockmodel images for senders and receivers of a relation are shown together; each set shows how the structures of sending and receiving the same relation differ. The ninth set is the reporting relation.

The face validity of the CALCOPT partition is assessed here in two ways. I first fit subgroups in the partition to the regional office memberships and second use subgroup memberships to interpret the structure of reporting relationships. These comparisons are instructive because they illustrate in some detail the kind of information networks in blockmodel form provide and thereby add indirectly to the interpretation of the hypothesis tests.

Geography. As shown in Table B4, the fit between geography and group membership is quite strong. The members of groups I to III belong only to the Canadian office. Group IV contains mostly Canadian members. Group V is a large group composed predominantly of the members of the Washington and Far West offices; most of the members of a small separate office in New York are also in this group. Group VI is a small cluster located in Washington, and the remaining groups are located, almost exclusively, in New York.

Relations between groups transcend geographical boundaries (refer to the blockmodel in Table B1). Of the groups with only Canadian members, group I has the most ties with groups outside Canada, whereas group II has only one tie and group III has none. Group IV includes four of the five offices and has a number of ties to all other groups except XIII and XIV. A small group in the Washington office, group VI, has many relationships with the other groups, except those that contain only Canadian members; and many of the remaining groups, primarily located in New York, are related to groups outside

TABLE B3

BLOCKMODEL IMAGES FOR EACH TYPE OF RELATION

Roman numerals refer tc the CALCOPT groups listed in Table 4B

Groups from Table are ordered: 6 4 3 2 5 14 1 9 11 12 8 10 7 13

A. Reporting (from subordinates point of view):

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1						1			1		1		
II	1	1	1											
III	1	1	1	1										
IV	1	1	1	1	1		1	1						
V	1			1	1	1	1			1				
VI						1	1							
VII							1			1		1		
VIII								1		1	1			
IX								1		1				
X														
XI							1	1		1	1	1		
XII														
XIII										1			1	1
XIV										1				

B. Feedback - Code: 1. Receive 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	2		2	2									
II	1 2	1 2	1 2	1 2	1 2									
III	1	2	1 2	1 2										
IV	1 2	2	1	1 2	1 2		1	1						
V	1			1 2	1 2	1 2	1 2							
VI				1 2	1 2	1 2	1 2	1 2						
VII					1 2	2	1 2			2		2		2
VIII				1 2	2		1 2	1 2	1 2	1 2	1 2	1 2		
IX					2		1	2		1				
X				2			1 2	1 2	1 2		1 2	1 2	2	1 2
XI								1 2		1	1 2			
XII					2			2		2				
XIII													1 2	1 2
X							1			1			1 2	

C. Help (Time) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I		2		2	2									
II	1 2	1 2	1											
III	1 2	1 2	2	1 2										
IV	2	2	2	1 2	2			2						
V	1			2	2	1	1 2					2		
VI					1	1	1							
VII					2	2	1 2							
VIII				2	2	2	2	2	2	2	1			
IX							2	2	1 2	1 2				
X				2	2	2	2	2	2		2	2	2	
XI														
XII														
XIII													2	2
XIV										2			1 2	

D. Help (More than One Kind) Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2												
II	1	1 2	1											
III	1 2	1 2	1 2	1 2										
IV	1 2	1 2	1	1 2	1 2		1 2	1						
V				1 2	1 2		1 2					1 2		
VI							1 2							
VII	1 2				2	2	1 2		2	1 2		1 2		1 2
VIII				1 2			1 2	1 2	1 2	1 2	1 2	1 2		
IX														
X						2	1 2	2			2		2	2
XI										1				
XII	1 2			2	1 2		1 2	1 2	2	1 2	2			2
XIII													1	1
XIV														

E. Information (Administrative) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2	1	1			1 2							
II	1 2	1 2		1										
III	1 2		1 2											
IV		2			1			1						
V				1	1 2		1					1 2		
VI					1					1		1		
VII	1 2				1 2	2			2	1 2		1	2	
VIII							1			1				
IX							1			1				
X						2							2	
XI							1					1		
XII							1		2	1 2		2		1
XIII										1				1
XIV							1			1				

F. Information (Marketing) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1			1 2										
II	1	1		1 2										
III	1			1										
IV	1 2	1 2	1 2	1 2	1 2									
V				1 2	1 2		1 2					1		
VI							1	1		1		1		
VII	2			1	1 2	1	1 2	1 2	1 2	1 2		1 2		
VIII							1 2			1 2		1		
IX					1 2		1 2	2						
X							1		1 2					
XI							1							
XII					2		2	2		1				
XIII														
XIV														

G. Information (More than One Kind) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2		1 2										
II	1	2												
III	1													
IV	1				1 2		1 2							
V				2	1 2	1 2	1 2		2	1 2				
VI					1 2	1 2	1 2			2	1			
VII				2	1 2	1		2	2	1 2		1 2		2
VIII							1 2	1 2		1 2	1 2			
IX							2			2		2		
X							1 2	1 2	2		1 2			2
XI								1 2		1				
XII	1 2			1 2	1 2		1 2	1 2	1 2		1 2			
XIII														
XIV										2				

H. Information (Technical) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	2	1 2	1	1 2										
II	1 2	1 2	1 2	1 2	2									
III	1 2	1 2	1 2	1 2	2									
IV	1 2	1 2	1		1			1 2						
V				1 2	1 2	1 2	1 2	2	1 2			2		
VI				1 2	1 2	1 2	1 2	1 2			1 2			
VII				1 2	1 2	1	1 2	1	1 2		1 2		2	1 2
VIII				1 2		2	2	1 2	1 2	1 2	1 2	2		
IX	1	1		1 2	1		1 2	1 2	1 2	1 2	1 2		1	
X	1			1 2	1	1		1	1		1		1	1
XI				1 2	2	1 2	1 2	1 2	1 2	1	1 2	2		
XII														
XIII							1						1 2	1 2
XIV							1 2						1 2	

I. Problem Referral - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	2	2												
II	1 2	1 2	1 2	1 2	1									
III	1 2	1	1 2	1 2										
IV	2	2	2	2	2			1 2						
V	2			1 2	1 2	1 2	1 2	1						
VI				1	1 2	1 2	1	1						
VII					1 2	2	1 2	2	2	1 2		1		1
VIII				1 2		2	2	1 2	1 2	2	1 2			
IX				1	2		2	1 2	2	1 2	2			
X				1 2	2	2	1 2	1 2	1 2		1 2			
XI							1	1 2	1 2		1 2			
XII								1	1		1			
XIII													1 2	1 2
XIV														

TABLE B4

CROSS CLASSIFICATION OF CALCOPT PARTITION AND REGIONAL OFFICE MEMBERSHIP

Groups from Table B2B are ordered: 6 4 3 2 5 14 1 9 11 12 8 10 7 13

CALCOPT Group	Office: Canada	Washington	Far West	NY I	NY II
I	5	0	0	0	0
II	14	0	0	0	0
III	4	0	0	0	0
IV	5	0	1	2	1
V	1	8	8	4	3
VI	0	3	0	0	0
VII	0	1	0	7	0
VIII	0	0	0	5	0
IX	0	0	0	9	0
X	0	0	0	1	0
XI	0	0	0	4	0
XII	0	0	0	2	0
XIII	0	0	0	5	0
XIV	0	0	0	1	0

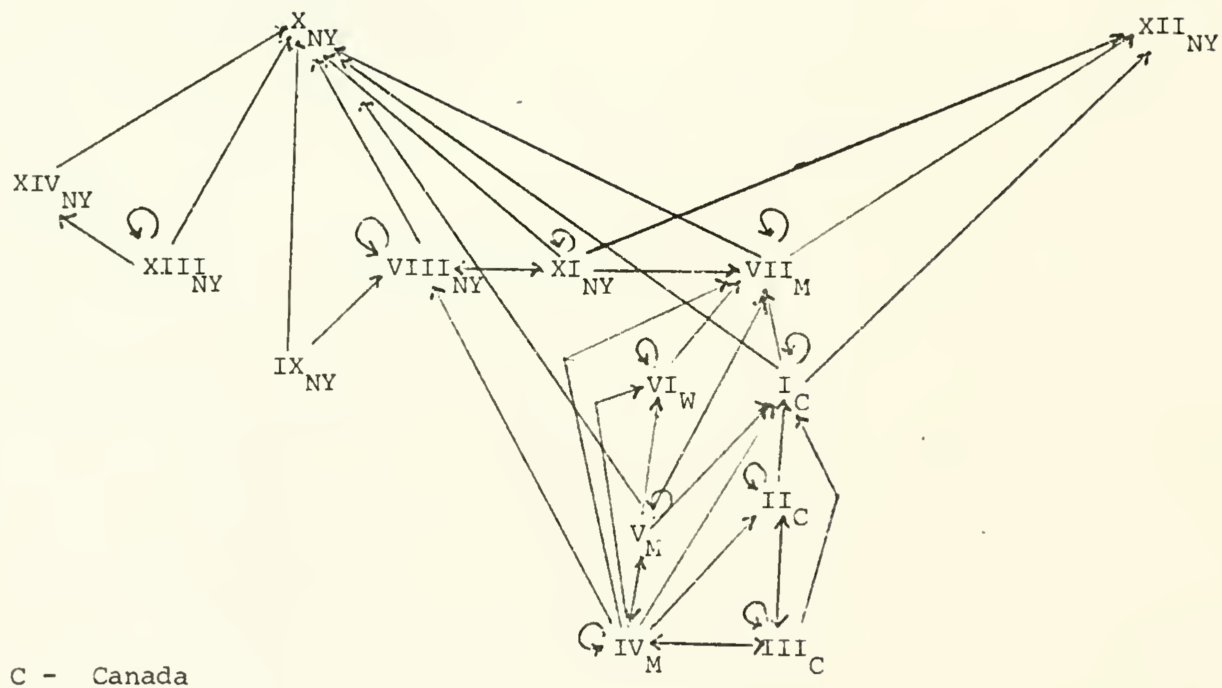
the New York region. The pattern of relationships thus shows substantial overlap, both within and between groups, among the geographically diversified offices.

<u>The Reporting Structure</u> A graph of the reporting structure is shown in Table B5. Five groups stand out as highly placed in the reporting hierarchy of the firm as a whole: I, in which the heads of the Canadian office are located, VXII, X, XII, and XIV. All other groups report directly to at least one of these. Positions X and XIV consist of a single member, and group XII has two members. The identity of these members is important for understanding the reporting structure. The sole member of group X is the firm's technical vice president; one member of group XII is the firm's marketing vice president; and the single member of group XIV is a project team leader whose team is located in group XIII.

The Canadian office (groups I through IV) follows virtually the classic hierarchical reporting pattern (virtually, because of reporting symmetry between groups II, III, and IV). The New York office, however, is fragmented into three hierarchies. Because of the idiosyncratic network positions of the single member groups, X and XIV, and that of the double member group, XII, two of these hierarchies overlap. The first hierarchy in New York is composed of groups XIII, XIV and X; group X is the apex of this order. No other groups report to XIII or XIV nor do groups XIII or XIV report to other groups outside the hierarchy. The second hierarchy consists of groups VII, VIII, IX, X, and XI. The apex of this hierarchy again is group X. Groups VIII and XI exchange reporting ties, the only case of symmetric reporting between groups outside Canada. The third hierarchy is groups VII, VIII, IX, XI and XII. The apex is group XII. Thus hierarchies two and three contain the same groups except for their apexes (see Friedell, 1967, for a discussion of such a structure as a semi-lattice).

TABLE B5

Directed Graph of Interposition Reporting



Positions are Roman numerals as shown in Table 5A

C - Canada

NY - New York

W - Washington

M - Mixture of geographical offices

The overlapping hierarchies in the New York office, therefore, are split between the technical and marketing vice presidents to both of whom group I also reports. The structure of reporting relationship thus provides information on cross-office and intra-office reporting patterns in the firm, and indicates as well potential conflict between the technical and marketing sides of the organization.